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Research Article

Guiding action on invasive alien species towards meeting the EU's Biodiversity Strategy for 2030

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Abstract

Invasive alien species (IAS) are a major threat to global biodiversity. The total cost of biological invasions across all European Union member states has been estimated at 129.9 billion US dollars between 1960 and 2020. It is, therefore, crucial to implement effective measures for IAS management. In Europe, the overarching mechanism for this is established through the European Union (EU) Biodiversity Strategy 2030, which aims to halve the number of Red List species threatened by IAS by 2030, namely by stepping up the implementation of the EU IAS Regulation. To support the implementation of the strategy, we use the Species Threat Abatement and Restoration (STAR) methodology to identify and quantify opportunities to reduce species extinction risk in the EU by managing invasive alien species (IAS), focusing specifically on its threat abatement component (STAR-t). Using data from the European Red List on extinction risk, threats and distribution for terrestrial and freshwater species groups (both animals and plants) threatened by IAS, we identified key geographic areas and species for intervention. The countries and territories providing the largest opportunities to contribute towards reducing EU species extinction risk through managing IAS are the Canary Islands [Spain] (20.8% of total EU STAR-t attributed to IAS), Madeira [Portugal] (14.2%), mainland Spain (11.9%), Italy (9.3%), Azores [Portugal] (5.4%) and Greece (5.3%). For specific IAS, the greatest opportunities to reduce regional species extinction risk by mitigating threats from IAS come from managing feral goats (12.4%), mouflons (8.1%), rabbits (5.3%) and rats (4.6%). This work showcases the first application of STAR at a regional scale to measure opportunities for threat abatement caused by IAS and provides practical application in guiding the management actions with the highest conservation gains towards the EU Biodiversity Strategy 2030.

Key words: Conservation biology, Red List, STAR metric, species management, threatened species

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Introduction

Over the past 50 years, the rate of alien species introductions has shown a significant and rapid growth worldwide, with threats from invasive alien species (IAS) continuing to rise across all regions (Seebens et al. 2017, 2021; IPBES 2023). The IAS are known as one of the main drivers of biodiversity loss overall and

particularly of species extinctions on island ecosystems (IPBES 2019, 2023). Their negative environmental impacts occur through a range of mechanisms, including competition, predation, biofouling or the transmission of pathogens (IUCN 2020). They also affect different constituents of human well-being, from health to material assets (Bacher et al. 2018). The global economic cost of invasive alien species was estimated to exceed US$423 billion annually as of 2019, with these costs having at least quadrupled every decade since 1970, primarily from negative impacts on nature's contributions to people, which support economic activities, as well as from management costs (Leroy et al. 2022; Sankaran et al. 2023). At a regional scale, the European Union (EU) has faced significant economic costs due to biological invasions, with recent estimates at approximately US$129.9 billion from 1960 to 2020 (Henry et al. 2023).

The IUCN Red List of Threatened Species™ is the world's most comprehensive information source on the extinction risk of species and the threats they face (IUCN 2024). IUCN Red List assessments can also be undertaken at a sub-global level (IUCN 2012) to support conservation planning and prioritisation relevant to national or regional policies. The European Red List (https://www.iucnredlist.org/regions/european-red-list) is one of the best known, most robust and most comprehensive such regional Red Lists, with over 13,000 species assessed within the EU across terrestrial, freshwater and marine groups, including all vertebrates (freshwater and marine fishes, amphibians, reptiles, birds and mammals), plus a number of invertebrate groups (bees, butterflies, dragon and damselflies, grasshoppers and crickets, freshwater and terrestrial molluscs and saproxylic beetles) and plants (bryophytes, ferns, shrubs, trees, aquatic vascular plants, vascular plants that are crop wild relatives and vascular plants listed in policy instruments). Across the EU, 3,759 species (excluding marine animals) have been assessed as Near Threatened or threatened (i.e., Vulnerable, Endangered or Critically Endangered) with extinction, of which 579 (15%) are documented to be threatened by IAS (IUCN 2024).

The EU Biodiversity Strategy for 2030, under its Target 12 (hereafter indicated as EU BDS 2030 IAS target), includes a key commitment to reduce by 50% the number of Red List species threatened by IAS (European Commission 2020). This is to be achieved by enhancing the implementation of the EU IAS Regulation (Regulation (EU) No 1143/2014 of the European Parliament and the Council, 22 October 2014, on the prevention and management of the introduction and spread of invasive alien species) and along with other relevant legislation and international agreements. The aim is to minimise and, where possible eliminate, the introduction and establishment of IAS in the EU environment and to manage IAS that are established in the EU (European Commission 2020). To support implementation of the EU BDS 2030 IAS target, we applied a modified version of the Species Threat Abatement and Restoration (STAR) metric (Mair et al. 2021), using IUCN European Red List data, to identify opportunities to reduce EU level species extinction risk through managing the threat caused by IAS.

The STAR metric was designed to quantify the potential impact of specific conservation actions in abating threats to species or habitat restoration within defined geographical areas, with the goal of reducing species extinction risk, in support of science-based target setting for species conservation across spatial scales (Mair et al. 2021). Specifically, threat abatement for species involves reducing the intensity of threats and/or taking actions to mitigate their impacts. The metric is derived from data in the IUCN Red List of Threatened Species™, specifically on species distri-

butions and habitats, documented threats to species and species extinction risk category (Near Threatened, Vulnerable, Endangered and Critically Endangered). To date, the metric has been developed using data from bird, mammal and amphibian species that have been assessed on the global IUCN Red List of Threatened Species (Mair et al. 2021). STAR assumes that completely removing threats would reduce extinction risk by halting population decline and/or promoting sufficient recovery in population size and distribution, ultimately allowing the species to be downgraded to the Least Concern category on the IUCN Red List. Importantly, the metric has the versatility to be applied to other datasets and taxonomic groups, for example, national Red Lists for vascular plants (Mair et al. 2023).

In this study, we applied the threat abatement component of STAR (STAR-t) to quantify and map IAS threat abatement opportunities using the IUCN European Red List data, aiming to identify the potential to reduce regional species extinction risk through managing IAS at country and site levels and targeting specific IAS. This approach was designed to support the EU and its 27 Member States, as well as three of its Outermost Regions closer to Europe, specifically the Macaronesian Islands, namely the Azores, Canaries and Madeira (collectively referred to as "EU territory" hereafter). This was done to assist in planning and implementing management measures that contribute to achieving the EU BDS 2030 IAS target.

Methods

We summarise our overall methodological approach in Fig. 1 and detailed it across the different methodological sections below.

Study area

We focused on the European Union and its 27 Member States, as well as three of its Outermost Regions closer to Europe, specifically the Macaronesian Islands, namely the Azores, Canaries and Madeira. It was not possible to include the remaining outermost regions (French Guiana, Guadeloupe, Martinique, Mayotte, Réunion Island and Saint-Martin) in our analysis. Incorporating these regions would have required reliance on data from global Red List assessments, which evaluate extinction risk at a global level rather than at a European level, as per the European regional Red List assessments and would have introduced inconsistencies in our methodology.

Species data input for analyses

The STAR threat abatement component (STAR-t) requires information on species' extinction risk, relative contribution of each threat to the species' extinction risk and current distribution range maps. As mentioned in step 1 from Fig. 1, this information was obtained for terrestrial and freshwater species from the European regional assessments accessed through the IUCN Red List (version 2021.3). We selected species assessed as Near Threatened or threatened (i.e. Vulnerable, Endangered or Critically Endangered) at the EU scale (Fig. 1; step 2).

Threats are a required component of IUCN Red List assessments for all species categorised as Near Threatened or Threatened (IUCN 2016). These threats are identified using the IUCN Threat Classification Scheme (Salafsky et al. 2008;

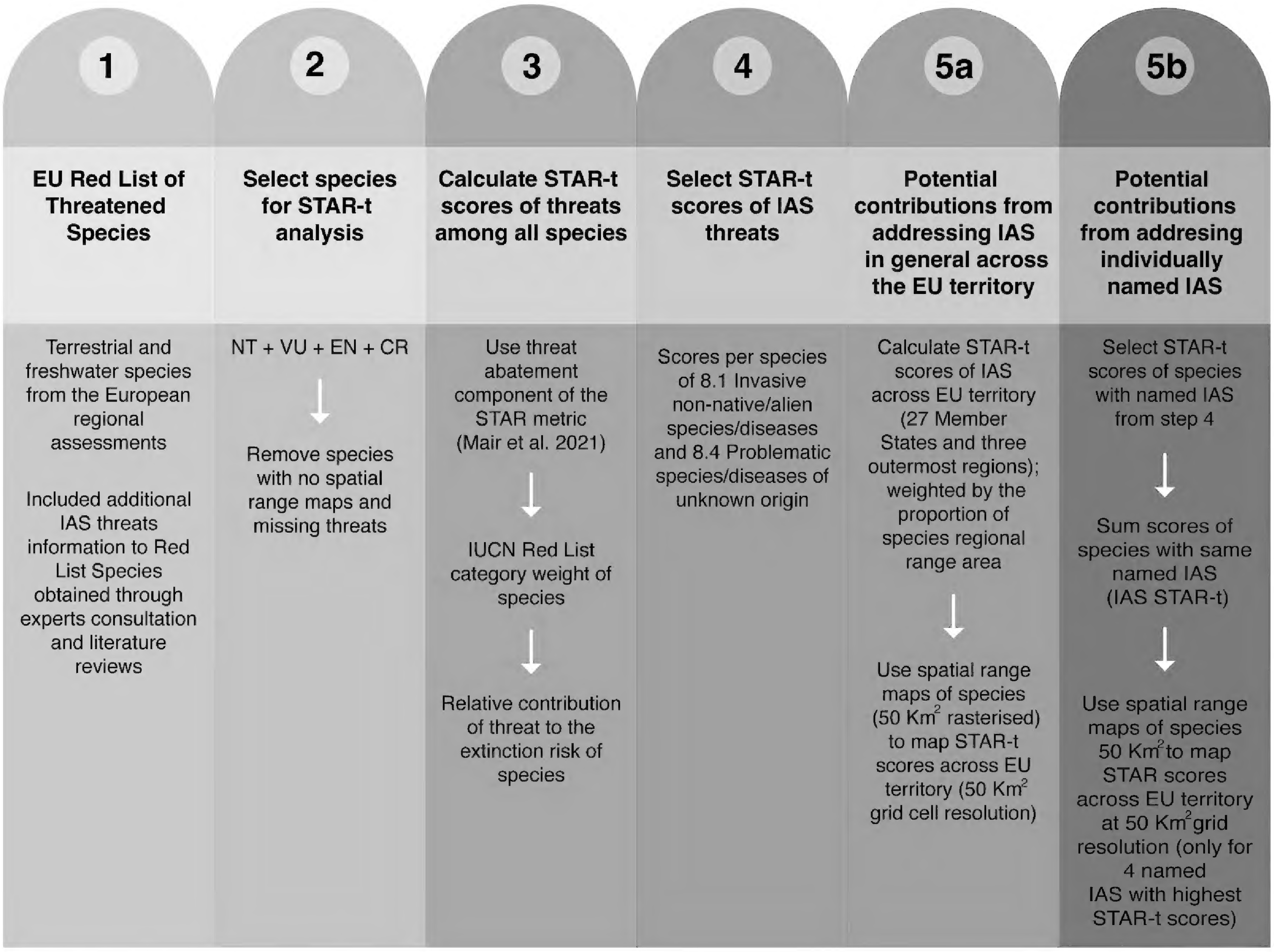

Figure 1. Methodological outline for the different steps of the STAR-t analyses on Invasive Alien Species threats. Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Critically Endangered (CR). The 8.1 (Invasive non-native/alien species/diseases) and 8.4 (Problematic species/diseases of unknown origin) refer to threat types from the IUCN Threat Classification Scheme (see more details in the text).

https://www.iucnredlist.org/resources/threat-classification-scheme), a standardised and hierarchical framework designed to categorise and assess the different types of threats faced by species. In addition to documenting the threats affecting each species, it is recommended to also provide information on the severity and scope of each of those threats. The severity of each threat denotes the overall population declines caused by a threat (e.g. causing or likely to cause very rapid declines (> 30% over 10 years or three generations; whichever is the longer)). Scope indicates the proportion of the total population impacted by the threat (e.g. affects the whole population (> 90%)).

Within the Threat Classification Scheme, two category types are relevant to IAS, threat 8.1 which relates to "Invasive non-native/alien species/diseases" and threat 8.4 which relates to "Problematic species/diseases of unknown origin". Where known, the specific IAS threatening the species in question is then documented under each of these two classes. Many of the IUCN Red List assessments from which information was retrieved are more than 10 years old and, therefore, for many of the threats coded as IAS, some of the data fields such as scope, severity and timing were 'unknown' or the IAS name was 'unspecified'. We therefore collated additional data on IAS threats posed to Red List species through a consultation exercise using experts on the various taxonomic groups considered here (Fig. 1; step 1; Appendix 1). The consultation was undertaken

through preparing and launching an online questionnaire asking about additional threats posed by IAS to species assessed on the European Red List through different channels. This was advertised in March 2022 through the Aliens-L mailing list, which is a list run by the IUCN SSC Invasive Species Specialist Group (ISSG) (Pagad et al. 2015) and the International Association for Open Knowledge on Invasive Alien Species (INVASIVESNET), which is a non-profit, non-governmental organisation open to individuals and organisations involved in research, management and exchange of knowledge on invasive species. It is important to note that these new data are in addition to the official European Red List data and, therefore, not available to be downloaded on the IUCN Red List website; instead, we provide these data here (See Suppl. material 1).

Due to existing confusion related to taxonomy, some species needed a slightly different approach. First, the data regarding mouflons are reported in the IUCN Red List as either *Ovis aries*, *Ovis ammon musimon* or *Ovis gmelini musimon*. *Ovis gmelini* and *O. ammon* are not confirmed with certainty to have been introduced in the EU, with only *O. aries* having been confirmed introduced in the region (Wilson and Mittermeier 2011). We, therefore, included all IAS records coded as the genus *Ovis* together with *O. aries*. Second, regarding *Rattus* species, many of the IAS threat records were coded as '*Rattus* unspecified', with additional records coded as either *R. rattus* or *R. norvegicus*; therefore, all *Rattus* threat records were combined into *Rattus* spp.

STAR-t scores calculation

Here, we used the threat abatement component of the STAR metric (STAR-t), which represents the threat abatement effort needed for species to become Least Concern (Mair et al. 2021). As mentioned in step 3 from Fig. 1, we calculated STAR-t score for any given site, based on the formula by Mair et al. (2021), using information on species extinction risk category, relative contribution of each threat to the species' extinction risk and species range maps from the European Red List. In this context, "site" denotes any specified area, where the maximum extent pertains to the EU territory, while the minimum practical size is defined by the spatial resolution of species range maps, set at 50-km^2 (see below for spatial data processing). In summary, we calculated STAR-t scores for a site and threats amongst all species as:

$$T_{t,i} = \sum_{S}^{N_s} P_{s,i} W_s C_{s,t}$$

where $P_{s,i}$ is the range of each species *s* within site *i* (expressed as a proportion of the species regional range area), W_s is the IUCN Red List category weight of species *s* (Near Threatened = 100; Vulnerable = 200; Endangered = 300; Critically Endangered = 400), *C* is the relative contribution of threat *t* to the extinction risk of species *s* and N_s is the total number of species at site *i*. We calculated the relative contribution of all recorded threats (i.e. from IAS and all other threat categories) to the extinction risk for each species. The relative contribution of each threat to the species' extinction risk is calculated as the percentage population decline from that threat (derived from the product of severity and scope for that threat in each species' European Red List assessment) divided by the sum of percentage population declines from all threats to that species, as in Mair et al. (2021). For species without information of severity and scope in their threats (See Suppl. material 2), we used the median value, as per Mair et al. (2021).

As also suggested in Mair et al. (2021), we excluded threats: i) recorded as having occurred in the past and unlikely to return and ii) not expected to cause a population decline. As a result, any threats that were not expected to lead to a decrease in population size were omitted from the analysis. Scores were calculated using the most detailed threat classification available and then aggregated to level 2 of the threat classification scheme by summing the scores.

For the STAR-t scores of IAS across the EU territory and individually named IAS, we focused on the scores linked to IAS through the threat categories 8.1 (Invasive non-native/alien species/diseases) and 8.4 (Problematic species/diseases of unknown origin) from the IUCN Threat Classification Scheme (Fig. 1; step 4). These scores were kept as a proportion of the total STAR-t score for each species, which accounts for all threats impacting them. This approach provides the actual weight of threats 8.1 and 8.4 in the STAR-t scores for the species. We carried out all analyses in R software (R Core Team 2021).

Potential contributions from addressing IAS in general across the EU territory

We calculated the proportion of the STAR-t score from the combined threats 8.1 and 8.4 relative to the total STAR-t score for the EU territory. Then, we calculated STAR-t scores associated with these combined threats for each of the 27 EU Member States and the three Outermost Regions (Azores, Canary Islands and Madeira) (Fig. 1; step 5a). To do this, we used species distribution range maps by extracting GIS spatial data (polygons) from the European Red List assessments via the IUCN Red List website and filtering these polygons using methods developed by Mair et al. (2021). Specifically, we included only the parts of each species' range where their origin was recorded as native, re-introduced or present through assisted colonisation, excluding areas coded as introduced, vagrant or with uncertain origin. Additionally, we excluded polygons where the species' presence was coded as extinct, possibly extant or uncertain. We then cropped the species polygons to the EU territory, including the EU Outermost Regions of Azores, the Canary Islands (Spain) and Madeira (Portugal), while excluding the French Outermost Regions and the EU Overseas Countries and Territories. Then, we rasterised these polygons at a 50-km^2 resolution and calculated the proportion of each species' range within each EU territory by overlaying the rasterised maps with EU territorial boundaries. There is no standard spatial resolution for IUCN Red List range maps; therefore, we decide to use a 50-km^2 resolution as a compromise between precision and accuracy (Rondinini et al. 2006). Using this spatial information, we calculated the STAR-t score for combined threats 8.1 and 8.4 in each EU territory by proportionally distributing the total score per species based on the area they occupied within each EU territory.

We mapped the STAR-t scores attributed to IAS (combined threats 8.1 and 8.4) for the EU territory at 50-km^2 grid cell resolution to be able to identify, at a relatively fine scale, the opportunities across the territory for contributing to the EU BDS 2030 IAS target through managing IAS (Fig. 1; step 5a). To do this, for each species threatened by IAS, we calculated the STAR-t score attributed to IAS per grid cell by multiplying each species' STAR-t score from combined threats 8.1 and 8.4 by the proportion of the species' range in the grid cell. We then generated the map for the EU territory by summing the STAR-t score maps across all species.

Potential contributions from addressing individually named IAS

We calculated the potential contribution to the EU IAS target that could be achieved by addressing threats caused by each of the named IAS documented as threatening species across the EU territory. For this, first we obtained the STAR-t scores attributed to IAS of species with identified named IAS for each Red List species in the EU territory (hereafter, IAS STAR-t score). For species threatened by more than one IAS (named and/or unnamed IAS species), we evenly divided the IAS STAR-t score amongst each IAS. Then, we summed the IAS STAR-t scores per named IAS to obtain the potential STAR contribution of abating a specific IAS in the EU territory (Fig. 1; step 5b).

We mapped the IAS STAR-t scores at a 50-km^2 grid cell resolution for the four most significant named IAS across the EU territory (i.e. with highest IAS STAR-t scores) (Fig. 1; step 5b). The IAS STAR-t score for each species was distributed proportionally to its range within each grid cell and the scores were then summed across all grid cells. It is important to note that these maps reflect the distribution of the impacted species and do not represent the distribution of the IAS. For instance, in some cases, IAS that threaten species in certain areas of the EU are native in other parts of the EU, such as the European rabbit (*Oryctolagus cuniculus*), which is native to the Iberian Peninsula, but typically alien and often invasive in other EU Member States outside its native range.

Results

A total of 1,495 of the 3,759 species assessed as Near Threatened or threatened at the EU level had all the necessary information (i.e. threats expected to cause a population decline and available species distribution data) to be included in the STAR-t score calculation to determine the relative contribution from addressing IAS in the EU territory relative to other threats affecting the species (See Suppl. material 3). The species groups with the highest percentage of Near Threatened or threatened species impacted by IAS (threats 8.1 and 8.4; not considering severity and scope) were bryophytes (17.3%), followed by freshwater fishes (12.4%), plants (policy) (11.2%), terrestrial molluscs (10.7%), shrubs (9.2%), trees (9%) and birds (6.9%) (Table 1). Of these, a total of 536 out of the 579 species documented as threatened by IAS within the EU territory had all the necessary information to be included in the STAR-t analyses related to IAS 8.1 and 8.4 threats (See Suppl. material 4).

Relative contributions from addressing IAS in the EU territory

Regarding STAR-t, we found that the extinction risk of species in the EU could be reduced by 16% if threats from IAS were completely abated (50,593 STAR-t score out of 325,300 total STAR-t score for EU territory).

Potential contributions from addressing IAS in general across the EU territory

The EU territories with the highest STAR-t scores attributed to IAS were the Canary Islands (20.8% of IAS STAR-t score), Madeira (14.2%), Spain (11.9%), Italy (9.3%), Azores (5.40%) and Greece (5.3%) (Fig. 2). While,

Table 1. Percentage of species groups documented as threatened by invasive alien species (IAS) under threats 8.1 and 8.4 of the IUCN threat classification scheme. This result does not reflect the severity of the IAS to the species.

Species group	Percentage (%)
Bryophytes	17.3
Fishes - freshwater	12.4
Plants (Policy)	11.2
Molluscs - terrestrial	10.7
Shrubs	9.2
Trees	9.0
Birds	6.9
Molluscs - freshwater	6.2
Reptiles	3.1
Amphibians	2.6
Crop Wild Relatives	2.6
Mammals	1.9
Orthopterans	1.6
Aquatic plants	1.4
Butterflies	1.4
Saproxylic beetles	1.0
Ferns	0.7
Bees	0.3
Odonata	0.3
Medicinal plants	0.2

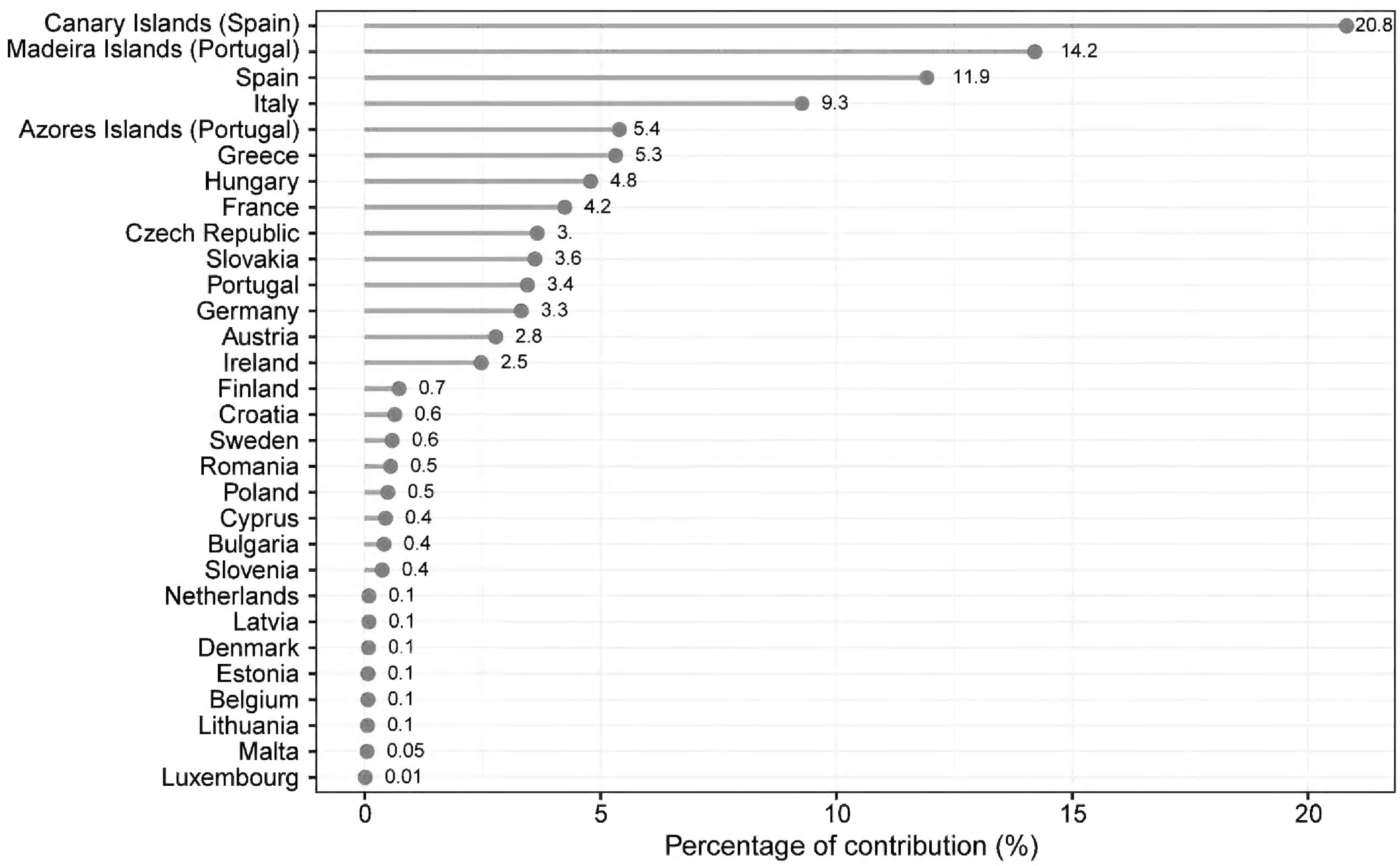

Figure 2. Contribution of IAS threat abatement to extinction risk reduction. Relative contribution (in percentage) to the species extinction risk reduction that could be met by acting to abate IAS threats in each of the EU Member States or Outermost Regions.

overall, there was a strong latitudinal gradient across the EU territory, with the greatest opportunities towards contributing to the EU BDS 2030 IAS target by reducing IAS threats in Macaronesia and the southern Mediterranean Region,

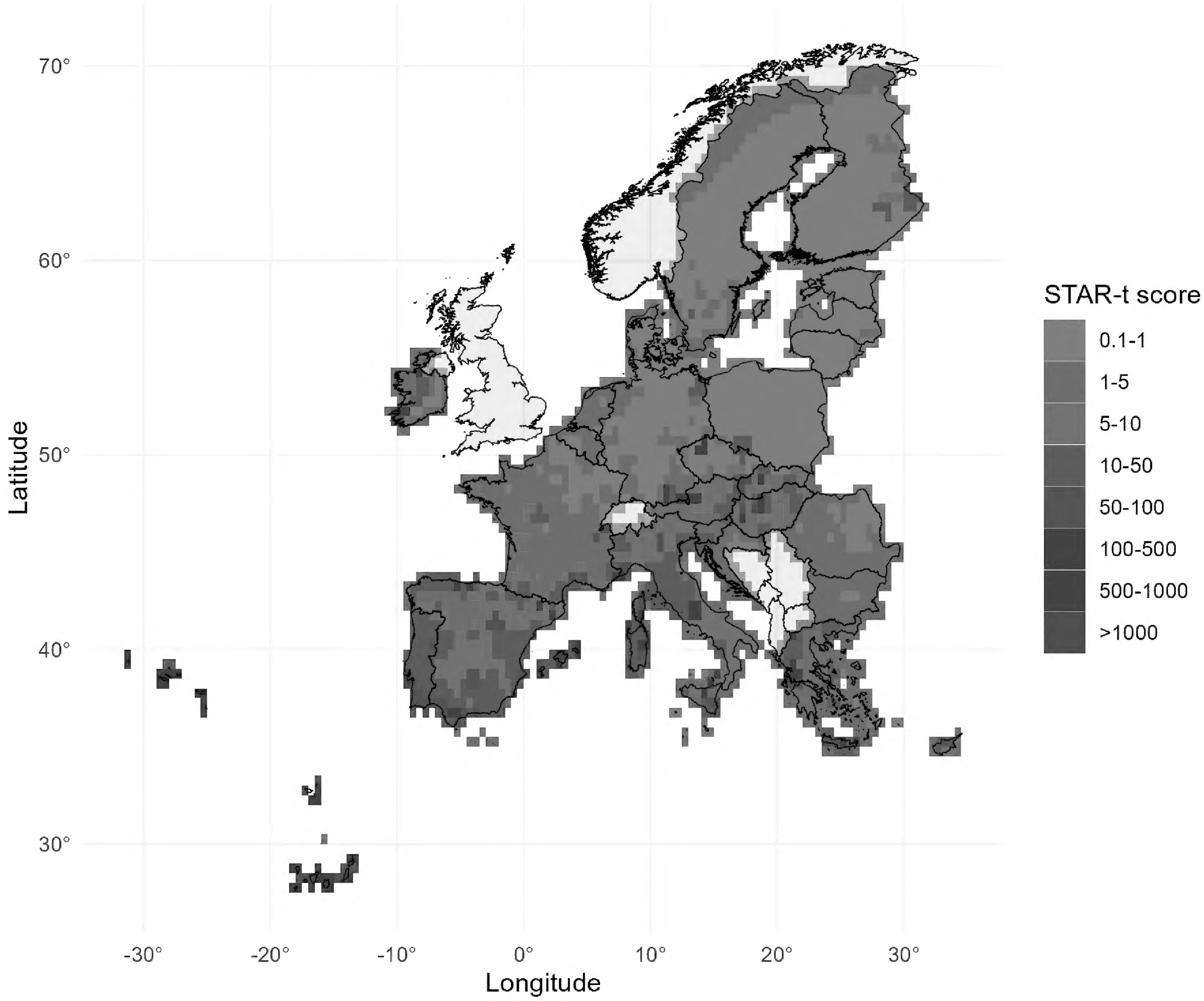

Figure 3. STAR-t scores attributed to IAS 8.1 and 8.4 threats. Scores are at a 50-km² grid cell resolution for the EU Member States or Outermost Regions considered in this study. Note that low scores do not mean that there are no threatened species present. Grey areas are non-EU countries which were not included in the analysis, but are shown to facilitate spatial visualisation.

there were also some areas of high opportunity in locations in the far north of the EU, for example, in eastern Finland (Fig. 3).

Potential contributions from addressing individually named IAS

We used the dataset consisting of 536 Near Threatened and threatened species documented as threatened by IAS within the EU territory mentioned above to identify named IAS and assess the potential contributions from addressing these individually named IAS within the EU territory. These 536 species are documented as threatened by 300 named IAS and, from those, the IAS with highest IAS STAR-t scores were the feral goat *Capra hircus* (12.40% of IAS STAR-t score attributed to named IAS), mouflons *Ovis aries* (8.1%), the European rabbit *Oryctolagus cuniculus* (5.3%), rats *Rattus* spp. (4.6%) and feral cats *Felis catus* (3.3%) (Suppl. material 5). These are the IAS that offer the greatest potential for reducing regional species extinction risk in the EU through targeted management. The Azores, Canary Islands, Madeira and the southern Mediterranean held the largest opportunity to reduce extinction risk through management of the first four IAS (Fig. 4A–D).

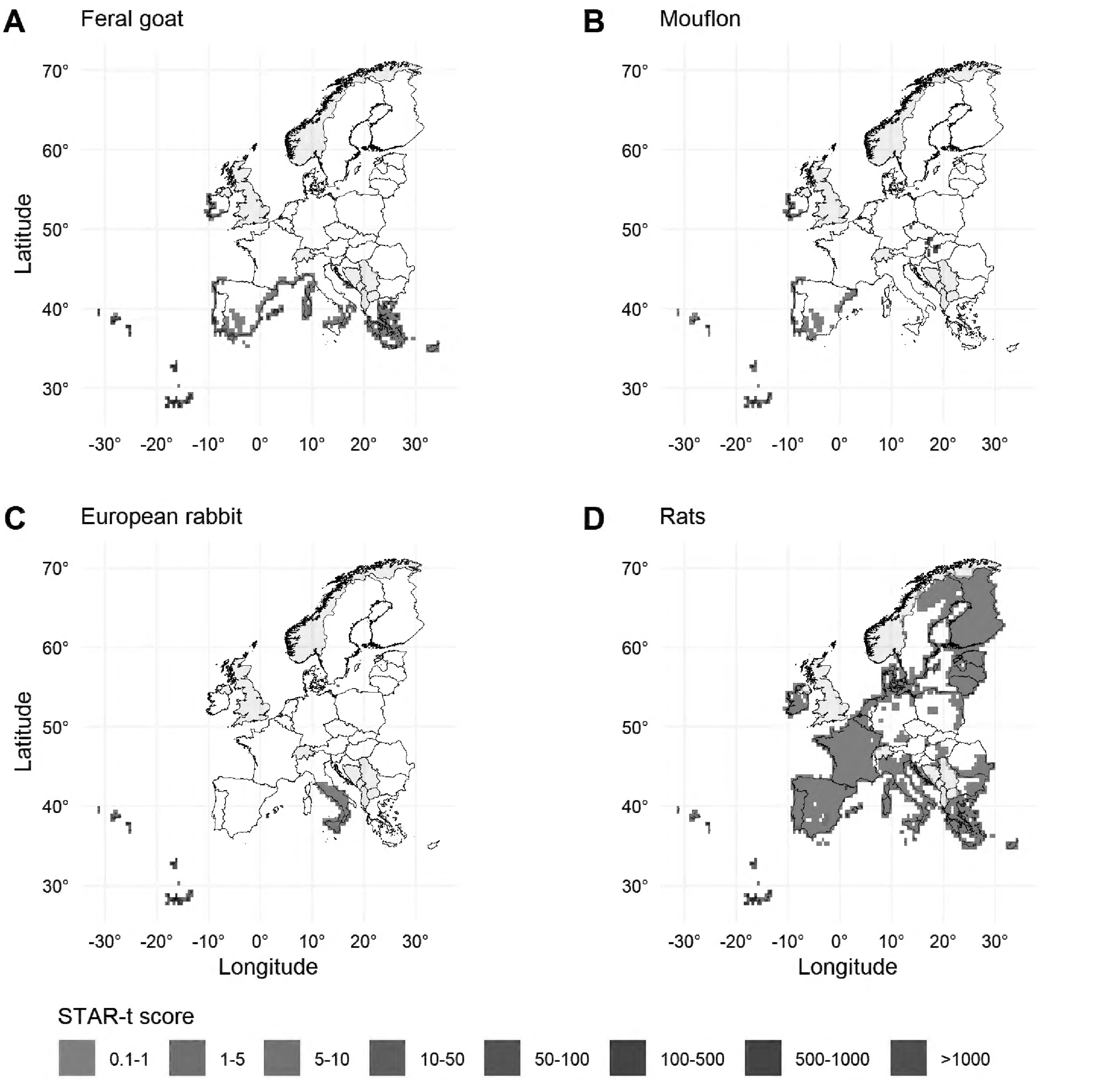

Figure 4. IAS STAR-t scores. IAS STAR-t that could be met by acting to abate the impact from **A** feral goat *Capra hircus* **B** mouflon *Ovis aries* **C** European rabbit *Oryctolagus cuniculus* and **D** rats *Rattus* spp. in the European Union. Note that *O. cuniculus* is native in parts of the EU territory. These maps represent the distribution of the impacted species rather than the distribution of the IAS. Grid cells are at a 50-km^2 resolution. Grey areas are non-EU countries which were not included in the analysis but are shown to facilitate spatial visualisation (See Suppl. material 6 for larger versions of maps).

Discussion

In this study, we quantify and map opportunities for IAS threat abatement, to contribute towards reduction of regional species extinction risk in the EU territory. To our knowledge, to date, no metric has been proposed to measure how much abating the threat of IAS stands to contribute towards the reduction of extinction risk over space, between geographical locations and across different IAS. The STAR-t, as presented in this paper, fills that gap.

It is clear from the results that the Macaronesian Islands and the Mediterranean Region in the EU territory offer the greatest opportunities to reduce regional species' extinction risk through the abatement of impacts from IAS. This is no surprise, given the high levels of endemism on island ecosystems and their vulnerability to impacts from biological invasions (e.g. see Bellard et al. (2016)). The EU BDS 2030

IAS Target aims to reduce by 50% the total number of Red List species threatened by IAS. This could be monitored by tracking the number of IUCN Red List species coded as having IAS as a threat or by applying the IUCN Red List index on the impacts of IAS (Butchart 2010; McGeoch et al. 2010; Genovesi et al. 2013). However, these indicators require species groups to be reassessed which could take up to ten years. In addition, they do not provide spatial information on where action can be taken to make the greatest progress towards the target. The results presented here using the STAR metric not only quantify total extinction risk at the EU level due to IAS, but also show where the greatest potential opportunities are for reducing this risk. Our results show that abating threats posed by IAS on the Azores, Canary Islands and Madeira alone could reduce the risk to threatened species in the EU territory by 40%. Actions to abate these threats would entail the precise identification and planning for management of populations of the IAS occurring in the territories highlighted by the STAR analysis (Tye 2018). Typically, management of IAS should be complemented by actions to address other threats in the same places and restore native biodiversity. Moreover, other factors beyond regional extinction risk, including global extinction risk, national conservation priorities, management feasibility, economic cost and political support, will normally be important in prioritising action. This said, our results underline the large potential conservation gains that could be made through IAS management on islands across the EU territory.

Our results demonstrate that continental Europe also offers opportunities for abating threats from IAS to reduce regional extinction risk, particularly across Spain, Italy and Greece. There is a strong latitudinal gradient across Europe, with opportunities tending to be the highest in the south Mediterranean. However, there are measurable opportunities for potential contribution to the overall IAS target across all the land area of all EU continental territory. While the complete removal of IAS from distinct areas may be more complex on larger land-masses than on islands, it is feasible in certain situations (Robertson et al. 2019). In addition, long-term control and containment can also offer opportunities for mitigating impacts from IAS, in particular from priority sites such as protected areas and Natura 2000 sites. It is important to bear in mind that, if an area shows a low STAR-t score, this still means that there are some IAS impacts potentially present. This indicates that these areas also hold the potential to contribute to reducing the risk of species extinction through targeted actions aimed at eliminating IAS.

We found a wide variation in opportunities to reduce regional species extinction risk amongst specific IAS. The feral goat provides the greatest opportunities for regional species extinction risk reduction through IAS response (12.0% from total EU IAS STAR-t score). Feral goats are widely recognised for the harm they cause to island vegetation and are one of the IAS causing the highest number of local extinctions on islands (Chynoweth et al. 2013; Bacher et al. 2023). More broadly, three of the five species with highest IAS STAR-t scores – feral goats, rats and cats – are the same three animals most frequently successfully eradicated from islands, resulting in major conservation gains (Jones et al. 2016; Spatz et al. 2022). Therefore, there is a real opportunity to achieve success in reducing extinction risk of threatened species through the removal of these IAS from specific areas. Where various IAS threaten species on a single island or other area, multiple IAS eradications at a site should be considered, given the need to take into account native and alien species interactions (Glen et al. 2013; Bode et al. 2015). In addition, it is also important to note that the management of some species (for example,

cats and mouflon, but not exclusively) can be controversial and generate conflict amongst the general public and animal welfare organisations. To prevent this, all stakeholders potentially linked with a particular species (including local communities) should be engaged from the beginning, to ensure that, amongst other factors, the social dimension of the actions is considered and addressed in the management strategy developed (Novoa et al. 2018).

It is of note that the STAR metric presented here is based on European Red List assessments representing extinction risk at the EU level for 21 different groups of animals and plants only. As such, IAS impacts to native species that are not assessed as Near Threatened or threatened at the EU scale or that are part of a taxonomic group that has not yet been assessed (for example, many marine species and plant, fungi and invertebrate taxa), are not represented in this analysis. Therefore, areas with low or no STAR-t score should not be interpreted as having no IAS present or little or no impacts from IAS occurring. For example, IAS impacts may be occurring in these areas upon native species of national concern or upon species that have not been assessed for the European Red List. Conversely, the heat maps for individual IAS are based on the ranges of Near Threatened and threatened species within the EU that are impacted by the IAS and do not represent the distribution of the IAS itself. Thus, in some cases, IAS which threaten species in some areas of the EU are native (and even threatened themselves) elsewhere in the EU; the European rabbit, native to the Iberian Peninsula where it is Endangered, but alien and often invasive in other EU Member States, is a good example (Villafuerte and Delibes Mateos 2019).

It is imperative to consider that the precise identification of which IAS and areas to target for interventions would require high resolution spatial data on the local distribution of the IAS in question. As a result of these caveats and of challenges in acquiring appropriate datasets/maps for IAS distribution, dedicated research on IAS regional or local distribution should be promoted wherever necessary within the broad jurisdictions identified here. Furthermore, the priority species (and areas) identified will need to undergo risk management to identify feasibility and cost-effectiveness of different management actions, by the local authorities and other stakeholders involved. For a summary of sources of uncertainty and methods to reduce uncertainty in STAR calculations, see Suppl. Material 7.

All IAS management actions, including island eradications, are context specific and their success depends upon a variety of factors beyond the application of the IAS management method itself (Booy et al. 2020). As mentioned above, while our study focuses on identifying the most relevant areas and species on which to address actions, the design and implementation of these must be carried out by the relevant authorities or other stakeholders. For this, a risk management process needs to be developed, given that the actual management of any target species, including the management objective and measures implemented, is highly context dependent. It will depend on local conditions, applicable legislation, overall resources available, policy willingness and many other factors. It is also important to define the objective of the management actions given that eradication, although certainly the most desirable option (especially in islands), might not be the only option available. For example, if rabbits cannot be completely eradicated from all the Canary Islands, it might be worth investigating if, in case the population is managed under a certain threshold or restrained from certain priority areas, this may ensure a satisfactory conservation status of the threatened species that are impacted by this species.

Furthermore, it is important to have community engagement, socio-economic values attached to the species, welfare considerations, legal frameworks and institutional mandates, resource allocation and interaction with other drivers such as climate change. Additionally, effective restoration and monitoring are essential to achieving sustainable conservation outcomes over the long term (Singh and Byun 2023).

While our research presents results indicating where conservation gains can be made through threat abatement from established IAS in the EU territory, it is imperative that any actions taken are coupled with measures to prevent their re-introduction, to prevent the introduction of other IAS and to implement any necessary restoration action. Therefore, the development and implementation of biosecurity and surveillance measures, along with early detection and rapid response capacity, are especially important (Sankaran et al. 2023). Furthermore, we also emphasise that stakeholders must consider the 50-km^2 resolution of our analyses when interpreting the results for localised conservation planning. We recommend that the findings be applied primarily at national or sub-national levels to support more detailed, higher-resolution planning efforts.

For STAR-t to be used not just as a metric for planning action, but also as an indicator of the success of interventions to control IAS, it needs to be calibrated locally using data on the actual occurrence simultaneously for each threatened species and each IAS in any given area, as well as threat intensity (Mair et al. *under review*). Active eradication or control of the IAS in question would be appropriate actions where local co-occurrence of the IAS and the threatened species are confirmed. By contrast, in areas where the threatened species occurs, but the IAS has not yet reached (but can possibly do so in a near future), proactive management through the implementation of prevention measures (e.g. biosecurity) and continuous surveillance are fundamental to prevent the arrival and/or establishment of the IAS in question. This would further support the implementation of monitoring and surveillance measures foreseen by the EU IAS Regulation. An example is provided by management activities carried out in the Island of Montecristo (Italy), one of the largest Mediterranean islands, where rats have been eradicated to protect the Yelkouan shearwater (*Puffinus yelkouan*) and other endangered species from predation (Sposimo et al. 2019) and where biosecurity measures are currently implemented to prevent new invasions.

Conclusion

Our findings offer a strategic framework for identifying opportunities to address IAS threats within the EU, advancing progress towards the EU BDS 2030 IAS Target. Achieving this goal requires coordinated efforts within both the whole EU and the individual Member State levels. Crucially, to yield results by 2030, relevant national authorities must enforce and accelerate implementation of actions to ensure mitigation of the impacts of IAS on Threatened and Near Threatened species, towards the EU BDS 2030 IAS Target. We recommend that authorities and stakeholder groups, including protected areas management authorities, governments, academia and civil society groups, should use these results at national or subnational level to provide information for higher resolution planning. Thus, we emphasise the importance of locally calibrating STAR-t using data on the actual occurrence of each threatened species and each IAS simultaneously, in order to ensure that any IAS control interventions are undertaken in the most appropriate and relevant locations. Regardless of the current availability of updated maps of the target IAS, our preliminary findings suggest that

Spain, Portugal, Italy and Greece have the greatest opportunities to take the lead in starting this process and address the IAS threat. However, gains may also be made in other Member States across the EU, as there are many opportunities elsewhere.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

References

Bacher S, Blackburn TM, Essl F, Genovesi P, Heikkilä J, Jeschke JM, Jones G, Keller R, Kenis M, Kueffer C, Martinou AF, Nentwig W, Pergl J, Pyšek P, Rabitsch W, Richardson DM, Roy HE, Saul W-C, Scalera R, Vilà M, Wilson JRU, Kumschick S (2018) Socio-economic impact classification of alien taxa (SEICAT). Methods in Ecology and Evolution 9: 159–168. https://doi.org/10.1111/2041-210X.12844

Bacher S, Galil B, Nuñez M, Ansong M, Cassey P, Dehnen-Schmutz K, Fayvush G, Hiremath A, Ikegami M, Martinou A, McDermott SM, Preda C, Vilà M, Weyl OLF, Fernandez RD, Ryan-Colton E (2023)

Impacts of invasive alien species on nature, nature's contributions to people, and good quality of life. In: Roy HE, Pauchard A, Stoett P, Truong Renard T (Eds) Chapter 4: Thematic assessment report on invasive alien species and their control of the intergovernmental science-policy platform on biodiversity and ecosystem services. IPBES Secretariat, Bonn. https://doi.org/10.5281/zenodo7430731

Bellard C, Cassey P, Blackburn TM (2016) Alien species as a driver of recent extinctions. Biology Letters 12: 20150623. https://doi.org/10.1098/rsbl.2015.0623

Bode M, Baker CM, Plein M (2015) Eradicating down the food chain: Optimal multispecies eradication schedules for a commonly encountered invaded island ecosystem. Journal of Applied Ecology 52(3): 571–579. https://doi.org/10.1111/1365-2664.12429

Booy O, Robertson PA, Moore N, Ward J, Roy HE, Adriaens T, Shaw R, Van Valkenburg J, Wyn G, Bertolino S (2020) Using structured eradication feasibility assessment to prioritize the management of new and emerging invasive alien species in Europe. Global Change Biology 26(11): 6235–6250. https://doi.org/10.1111/gcb.15280

Butchart SHM, Walpole M, Collen B, van Strien A, Scharlemann JPW, Almond REA, Baillie JEM, Bomhard B, Brown C, Bruno J, Carpenter KE, Carr GM, Chanson J, Chenery AM, Csirke J, Davidson NC, Dentener F, Foster M, Galli A, Galloway JN, Genovesi P, Gregory RD, Hockings M, Kapos V, Lamarque J-F, Leverington F, Loh J, McGeoch MA, McRae L, Minasyan A, Morcillo MH, Oldfield TEE, Pauly D, Quader S, Revenga C, Sauer JR, Skolnik B, Spear D, Stanwell-Smith D, Stuart SN, Symes A, Tierney M, Tyrrell TD, Vié J-C, Watson R (2010) Global biodiversity: Indicators of recent declines. Science 328: 1164–1168. https://doi.org/10.1126/science.1187512

Chynoweth MW, Creighton ML, Christopher AL, Steven C. Hess, Susan Cordell (2013) Biology and impacts of Pacific Island invasive species. 9. *Capra hircus*, the Feral Goat (Mammalia: Bovidae). Pacific Science 67(2): 141–156. https://doi.org/10.2984/67.2.1

European Commission (2020) EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, 1–380.

Genovesi P, Butchart SHM, McGeoch MA, Roy DB (2013). Monitoring trends in biological invasion, its impact and policy responses. In: Collen B, Pettorelli N, Ballie JEM, Durrant SM (Eds) Biodiversity monitoring and conservation: bridging the gap between global commitment and local action. Wiley, Chichester, 138–158. https://doi.org/10.1002/9781118490747.ch7

Glen AS, Atkinson R, Campbell KJ, Hagen E, Holmes ND, Keitt BS, Parkes JP, Saunders A, Sawyer J, Torres H (2013) Eradicating multiple invasive species on inhabited islands: The next big step in island restoration? Biological Invasions 15: 2589–2603. https://doi.org/10.1007/s10530-013-0495-y

Henry M, Leung B, Cuthbert RN, Bodey TW, Ahmed DA, Angulo E, Balzani P, Briski E, Courchamp F, Hulme PE, Kouba A, Kourantidou M, Liu C, Macêdo RL, Oficialdegui FJ, Renault D, Soto I, Tarkan AS, Turbelin AJ, Bradshaw CJA, Haubrock PJ (2023) Unveiling the hidden economic toll of biological invasions in the European Union. Environmental Sciences Europe 35: 43. https://doi.org/10.1186/s12302-023-00750-3

IPBES (2019) Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. In: Brondizio ES, Settele J, Díaz S, and Ngo HT (Eds) IPBES Secretariat, Bonn. https://doi.org/10.5281/zenodo.3831673

IPBES (2023) Thematic assessment report on invasive alien species and their control of the intergovernmental science-policy platform on biodiversity and ecosystem services. In: Roy HE, Pauchard A, Stoett P, Renard Truong T, Bacher S, Galil BS, Hulme PE, Ikeda T, Sankaran KV, McGeoch MA, Meyerson LA, Nuñez MA, Ordonez A, Rahlao SJ, Schwindt E, Seebens H, Sheppard AW, Vandvik V (Eds) IPBES Secretariat, Bonn. https://doi.org/10.5281/zenodo.7430682

IUCN (2012) Guidelines for Application of IUCN Red List Criteria at Regional and National Levels 4.0. Gland, Switzerland and Cambridge, UK.

IUCN (2016) Rules of procedure for IUCN Red List assessments 2017–2020, version 3.0. Approved by the IUCN SSC Steering Committee in September 2016.

IUCN (2020) IUCN EICAT Categories and Criteria. The Environmental Impact Classification for Alien Taxa. https://doi.org/10.2305/iucn.ch.2020.05.en

IUCN (2024) The IUCN Red List of Threatened Species. Version 2021-3. https://www.iucnredlist.org

Jones HP, Holmes ND, Butchart SHM, Tershy BR, Kappes PJ, Corkery I, Aguirre-Muñoz A, Armstrong DP, Bonnaud E, Burbidge AA, Campbell K, Courchamp F, Cowan PE, Cuthbert RJ, Ebbert S, Genovesi P, Howald GR, Keitt BS, Kress SW, Miskelly CM, Oppel S, Poncet S, Rauzon MJ, Rocamora G, Russell JC, Samaniego-Herrera A, Seddon PJ, Spatz DR, Towns DR, Croll DA (2016) Invasive mammal eradication on islands results in substantial conservation gains. Proceedings of the National Academy of Sciences of the United States of America 113(15): 4033–4038. https://doi.org/10.1073/pnas.1521179113

Keller RP, Geist J, Jeschke JM, Kühn I (2011) Invasive species in Europe: Ecology, status, and policy. Environmental Sciences Europe 23: 23. https://doi.org/10.1186/2190-4715-23-23

Leroy B, Kramer AM, Vaissière A-C, Kourantidou M, Courchamp F, Diagne C (2022) Analysing economic costs of invasive alien species with the invacost r package. Methods in Ecology and Evolution 13: 1930–1937. https://doi.org/10.1111/2041-210X.13929

Mair L, Bennun LA, Brooks TM, Butchart SHM, Bolam FC, Burgess ND, Ekstrom JMM, Milner-Gulland EJ, Hoffmann M, Ma K, Macfarlane NBW, Raimondo DC, Rodrigues ASL, Shen X, Strassburg BBN, Beatty CR, Gómez-Creutzberg C, Iribarrem A, Irmadhiany M, Lacerda E, Mattos BC, Parakkasi K, Tognelli MF, Bennett EL, Bryan C, Carbone G, Chaudhary A, Eiselin M, da Fonseca GAB, Galt R, Geschke A, Glew L, Goedicke R, Green JMH, Gregory RD, Hill SLL, Hole DG, Hughes J, Hutton J, Keijzer MPW, Navarro LM, Nic Lughadha E, Plumptre AJ, Puydarrieux P, Possingham HP, Rankovic A, Regan EC, Rondinini C, Schneck JD, Siikamäki J, Sendashonga C, Seutin G, Sinclair S, Skowno AL, Soto-Navarro CA, Stuart SN, Temple HJ, Vallier A, Verones F, Viana LR, Watson J, Bezeng S, Böhm M, Burfield IJ, Clausnitzer V, Clubbe C, Cox NA, Freyhof J, Gerber LR, Hilton-Taylor C, Jenkins R, Joolia A, Joppa LN, Koh LP, Lacher TE, Langhammer PF, Long B, Mallon D, Pacifici M, Polidoro BA, Pollock CM, Rivers MC, Roach NS, Rodríguez JP, Smart J, Young BE, Hawkins F, McGowan PJK (2021) A metric for spatially explicit contributions to science-based species targets. Nature Ecology & Evolution 5: 836–844. https://doi.org/10.1038/s41559-021-01432-0

Mair L, Amorim E, Bicalho M, Brooks TM, Calfo V, Capellão RdeT, Clubbe C, Evju M, Fernandez EP, Ferreira GC, Hawkins F, Jiménez RR, Jordão LSB, Kyrkjeeide MO, Macfarlane NBW, Mattos BC, de Melo PHA, Monteiro LM, Nic Lughadha E, Pougy N, Raimondo DC, Setsaas TH, Shen X, de Siqueira MF, Strassburg BBN, McGowan PJK (2023) Quantifying and mapping species threat abatement opportunities to support national target setting. Conservation Biology 37: e14046. https://doi.org/10.1111/cobi.14046

Mair L, Bennun L, Brooks T, Jiménez RR, MacFarlane N, Nello T, Vergez A, Butchart S, Curet F, Dakmejian A, Ellis E, McGowan P, Ridley F, Ross A, Sneary M, Starnes T, Stephenson PJ, Turner J, Hawkins F (*under review*) Conceptual framework for the implementation of the Species Threat Abatement & Restoration metric's threat abatement component. Conservation Biology.

McGeoch MA, Butchart SHM, Spear D, Marais E, Kleynhans EJ, Symes A, Chanson J, Hoffmann M (2010) Global indicators of biological invasion: Species numbers, biodiversity impact and policy responses. Diversity & Distributions 16: 95–108. https://doi.org/10.1111/j.1472-4642.2009.00633.x

Novoa A, Shackleton R, Canavan S, Cybèle C, Davies SJ, Dehnen-Schmutz K, Fried J, Gaertner M, Geerts S, Griffiths CL, Kaplan H, Kumschick S, Le Maitre DC, Measey GJ, Nunes AL, Richardson DM, Robinson TB, Touza J, Wilson JRU (2018) A framework for engaging stakeholders on the management of alien species. Journal of Environmental Management 205: 286–297. https://doi.org/10.1016/j.jenvman.2017.09.059

Pagad S, Genovesi P, Carnevali L, Scalera R, Clout M (2015) IUCN SSC Invasive Species Specialist Group: Invasive alien species information management supporting practitioners, policy makers and decision takers. Management of Biological Invasions : International Journal of Applied Research on Biological Invasions 6: 127–135. https://doi.org/10.3391/mbi.2015.6.2.03

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Robertson P, Roy S, Mill AC, Shirley M, Adriaens T, Ward A, Tatayah V, Booy O (2019) Invasive species removals and scale–contrasting island and mainland experience. Island invasives: scaling up to meet the challenge. Occasional Paper SSC: 687-691.

Rondinini C, Wilson KA, Boitani L, Grantham H, Possingham HP (2006) Tradeoffs of different types of species occurrence data for use in systematic conservation planning. Ecology Letters 9: 1136–1145. https://doi.org/10.1111/j.1461-0248.2006.00970.x

Salafsky N, Salzer D, Stattersfield AJ, Hilton-Taylor C, Neugarten R, Butchart SH, Collen B, Cox N, Master LL, O'Connor S, Wilkie D (2008) A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. Conservation Biology 22: 897–911. https://doi.org/10.1111/j.1523-1739.2008.00937.x

Sankaran K, Schwindt E, Sheppard AW, Foxcroft LC, Vanderhoeven S, Egawa C, Peacock L, Castillo ML, Zenni RD, Müllerová J, González-Martínez AI (2023) Management; challenges, opportunities and lessons learned. In: Roy HE, Pauchard A, Stoett P, et al. (Eds) Thematic assessment report on Invasive Alien Species and their control of the intergovernmental science-policy platform on biodiversity and ecosystem services. IPBES Secretariat, Bonn, 970–982. https://doi.org/10.5281/zenodo.2023;7430733

Seebens H, Blackburn TM, Dyer EE, Genovesi P, Hulme PE, Jeschke JM, Pagad S, Pyšek P, Winter M, Arianoutsou M, Bacher S, Blasius B, Brundu G, Capinha C, Celesti-Grapow L, Dawson W, Dullinger S, Fuentes N, Jäger H, Kartesz J, Kenis M, Kreft H, Kühn I, Lenzner B, Liebhold A, Mosena A, Moser D, Nishino M, Pearman D, Pergl J, Rabitsch W, Rojas-Sandoval J, Roques A, Rorke S, Rossinelli S, Roy HE, Scalera R, Schindler S, Štajerová K, Tokarska-Guzik B, van Kleunen M, Walker K, Weigelt P, Yamanaka T, Essl F (2017) No saturation in the accumulation of alien species worldwide. Nature Communications 8(1): 14435. https://doi.org/10.1038/ncomms14435

Seebens H, Bacher S, Blackburn TM, Capinha C, Dawson W, Dullinger S, Genovesi P, Hulme PE, van Kleunen M, Kühn I, Jeschke JM, Lenzner B, Liebhold AM, Pattison Z, Pergl J, Pyšek P, Winter M, Essl F (2021) Projecting the continental accumulation of alien species through to 2050. Global Change Biology 27: 970–982. https://doi.org/10.1111/gcb.15333

Singh K, Byun C (2023) Ecological restoration after management of invasive alien plants. Ecological Engineering 197: 107122. https://doi.org/10.1016/j.ecoleng.2023.107122

Spatz DR, Holmes ND, Will DJ, Hein S, Carter ZT, Fewster RM, Keitt B, Genovesi P, Samaniego A, Croll DA, Tershy BR, Russell JC (2022) The global contribution of invasive vertebrate eradication as a key island restoration tool. Scientific Reports 12(1): 13391. https://doi.org/10.1038/s41598-022-14982-5

Sposimo P, Capizzi D, Cencetti T, De Pietro F, Giannini F, Gotti C, Puppo F, Quilghini G, Pelliccioni ER, Sammuri G, Trocchi V (2019) Rat and lagomorph eradication on two large islands of central Mediterranean: differences in island morphology and consequences on methods, problems and targets. Island invasives: scaling up to meet the challenge. Occasional Paper SSC 62: 231-235.

Tye A (2018) Guidelines for invasive species planning and management on islands. International Union for Conservation of Nature, Gland, Switzerland. https://doi.org/10.2305/IUCN.CH.2018.15.en

Villafuerte R, Delibes-Mateos M (2019) *Oryctolagus cuniculus* (European Rabbit). The IUCN Red List of Threatened Species. e.T41291A45189779. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T41291A45189779.en

Wilson DE, Mittermeier RA (2011) Handbook of the mammals of the world, Vol. 2: Hoofed mammals. Lynx Ediciones, Barcelona, Spain.

Appendix 1

Expert consultation undertaken to collate addition information on IAS threats to IUCN Red List species.

Methodology

To collate additional information on IAS threats to IUCN Red List species we undertook four separate exercises:

Reviewing the IUCN Red List assessment threat text

Each IUCN Red List assessment contains textual information on the threats posed to the species, providing a rationale for the threat categories coded as part of the assessment. IUCN staff reviewed this text for all 295 NT/threatened species in the EU Red List species dataset that had 'unspecified species' coded under the threat categories: "*8.1 Invasive non-native/alien species/diseases*", and "*8.4 Problematic species/diseases of unknown origin*". This allowed for any species level names of IAS noted in the text, but not coded in the classification scheme, to be identified.

Contacting IUCN Red List assessors

IUCN emailed all of the assessors for the 295 NT/threatened species in the EU Red List species dataset where threats from IAS were coded as 'unspecified species'. The assessor was requested to provide the species level name(s) for the IAS coded as 'unspecified'. Altogether 223 emails were sent, but the number of assessors contacted was actually higher as, in most cases, more than one assessor was named in the IUCN Red List database.

Launching an online consultation exercise

An online consultation was undertaken to solicit information on the species names for those IAS coded as 'unspecified', and on IAS not currently listed as a threat to the NT/threatened species in the EU Red List species dataset. The consultation was open from 01/03/22 to 27/03/22 using an online Microsoft form to collate responses. In order to reach potential experts, IUCN circulated a request for engagement on the consultation on the Aliens-L email list serve which has 1,502 members (email sent on 01/03/22 and a reminder on 22/03/22), and also in the INVASIVESNET Spring 2022 email newsletter (sent 14/03/22).

Sub-contracting experts on assessment groups

IUCN sub-contracted five experts to identify IAS threats to eight EU Red List species dataset priority 'groups' identified based on the high number of IAS

threats coded as 'unspecified species', these were: mammals; trees; shrubs; vascular plants in policy; amphibians; reptiles; terrestrial molluscs; and freshwater molluscs. These eight species groups totalled 1,920 NT/threatened species, out of a total of 3,783 NT/threatened species in the whole EU RL dataset (representing 51%).

Results

A total of 555 new data records (e.g. names of IAS previously coded as 'unspecified' or a new IAS not previously recorded) were mobilised across the four different steps. In terms of results for each individual step:

2.1. Twenty-six (26) IUCN Red List assessments were found to hold threat text that identified the species name of the IAS coded as 'unspecified' (an additional 9 records identified the IAS to genus level, e.g. Acacia spp.)
2.2. Out of the 223 emails sent, 11 IUCN Red List assessors responded to the emails with new information, covering 36 Red List species. Nineteen other assessors also responded but did not provide new information.
2.3. Only 3 responses were received through the online consultation, covering 4 Red List species.
2.4. The subcontracted experts mobilised new threat information for 183 Red List species.

Supplementary material 1

Supplementary information

Authors: Randall R. Jiménez, Kevin G. Smith, Thomas M. Brooks, Riccardo Scalera, Louise Mair, Ana L. Nunes, Katie E. Costello, Nicholas B. W. Macfarlane

Data type: xlsx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl1

Supplementary material 2

Number of IAS threats with severity and scope on STAR-t analyses

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Data type: xlsx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl2

Supplementary material 3

Summary of species assessed in the EU Red List and data gaps relevant to STAR-t analysis

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Data type: xlsx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl3

Supplementary material 4

Species from the EU Red List included in STAR analysis for Invasive Alien Species (IAS)

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Data type: xlsx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl4

Supplementary material 5

IAS STAR-t that could be met by acting to abate the impact from named IAS

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Data type: xlsx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl5

Supplementary material 6

STAR-t scores by four IAS

Authors: Randall R. Jiménez, Kevin G. Smith, Thomas M. Brooks, Riccardo Scalera, Louise Mair, Ana L. Nunes, Katie E. Costello, Nicholas B. W. Macfarlane

Data type: docx

Link: https://doi.org/10.3897/neobiota.99.148323.suppl6

Supplementary material 7

Summary of sources of uncertainty in the calculation of STAR-t scores, and approaches to reduce these uncertainties

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